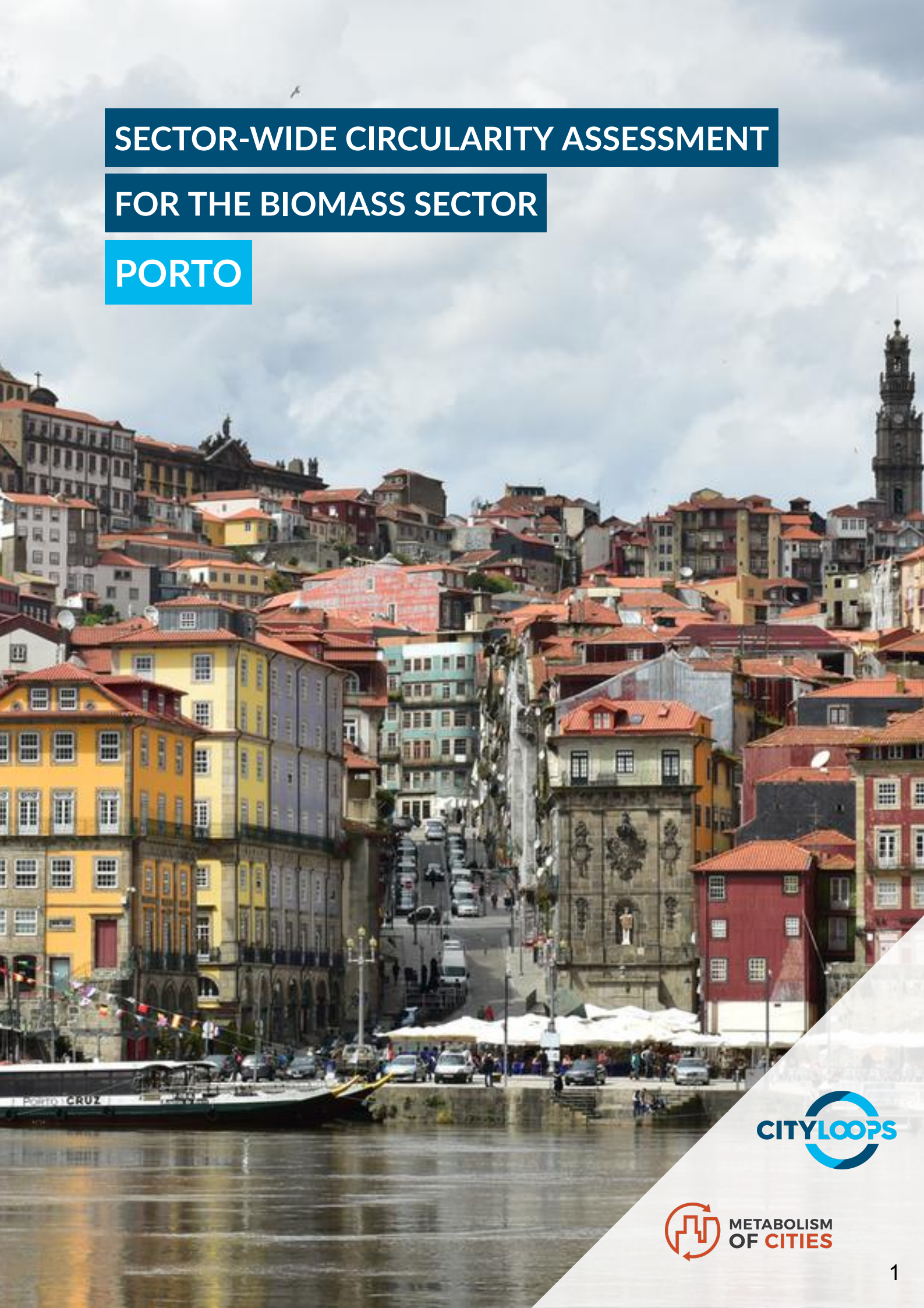
SECTOR-WIDE CIRCULARITY ASSESSMENT FOR THE BIOMASS SECTOR

PORTO



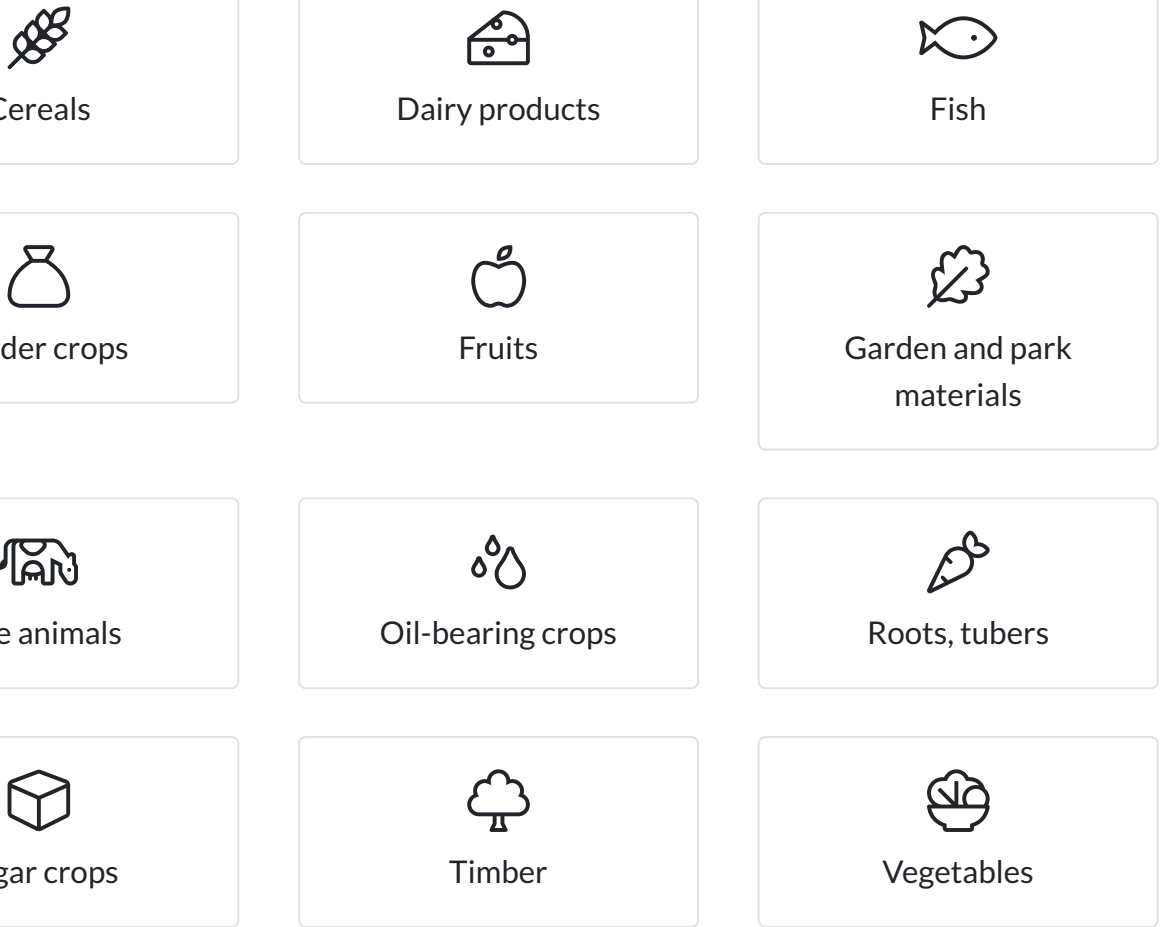
CITYLOOPS

METABOLISM OF CITIES

Introduction

The EU Horizon 2020 funded CityLoops project focuses on closing the material loops of two central sectors of any city in terms of material flows, societal needs and employment, namely the construction and biomass sectors. Due to their sizes, they represent a considerable opportunity for cities to transform their metabolism and economy towards a more circular state.

Within this project, seven European cities, amongst those also the City of Porto are planning to implement demonstration actions to kickstart their circularity journey. To better understand what the current circularity status quo is, as well as the impact of these actions, and the efforts needed to transform their sector, a Sector-Wide Circularity Assessment method was developed. This method combines a circular city and circular sector definition, a material flow and stock accounting method, as well as circularity indicators. The sector itself was defined in terms of a number of representative materials that make up a large share of the sector and associated economic activities. The biomass sector is made up of 12 materials, depicted as icons here, which were studied along the entirety of their supply chains. Altogether, these elements help to set a solid knowledge and analytical foundation to develop future circularity roadmaps and action plans.



The assessment was carried out by the cities themselves after receiving extensive training in the form of courses on data collection (construction and biomass) and data processing. Numerous additional insights can be found in the individual Data Hubs of each city.

This current Sector-Wide Circularity Assessment report provides contextual information on the city and the economic sector under study. It then illustrates how circular these sectors are through circularity indicators and a Sankey diagram. Finally, it analyses and interprets the results, presents the limitations from the data used and offers recommendations about how to make this sector more circular.

(The italic texts in this report were written by Metabolism of Cities' Aristide Athanassiadis and Carolin Bellstedt. They provide relevant general information and serve as connecting elements of the single report parts.)*

Urban context

To contextualise the results of the sector-wide circularity assessment, this section provides population and land use information data of the city. In addition, population and area of the city under study, as well as its corresponding NUTS3, NUTS2 and country were included. Data for these scales were added to better understand how relevant and important the approximations are when downscaling data from these scales to a city level.

Porto

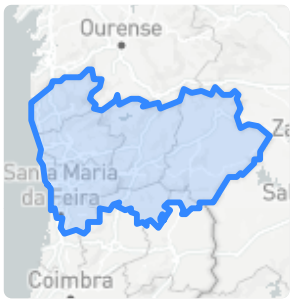
216,606

41 km^2

Área Metropolitana do Porto

1,728,226

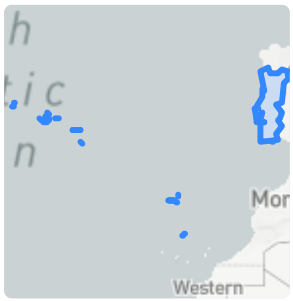
2,041 km^2



Norte

3,575,338

21,286 km^2

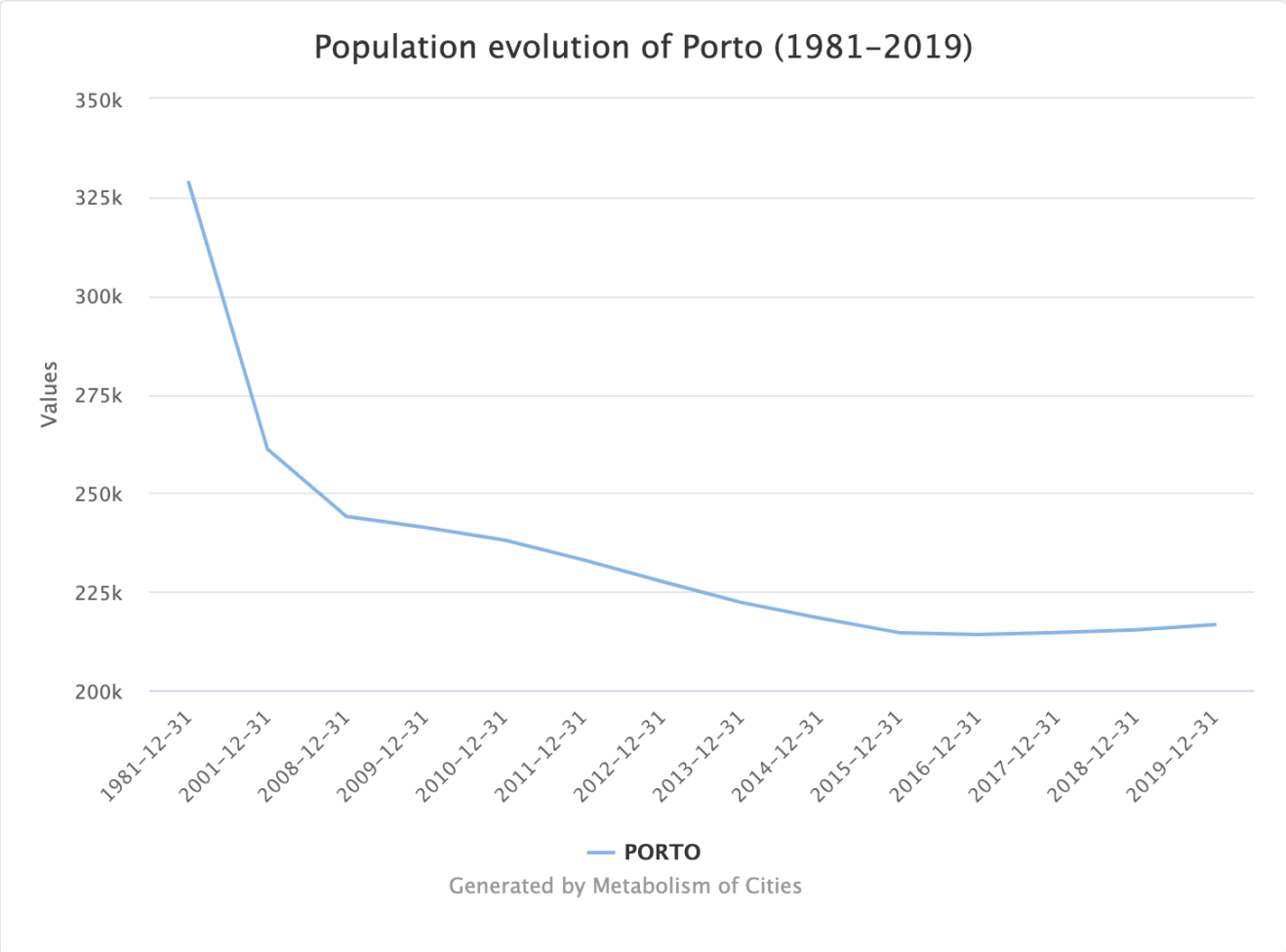


Portugal

10,295,909

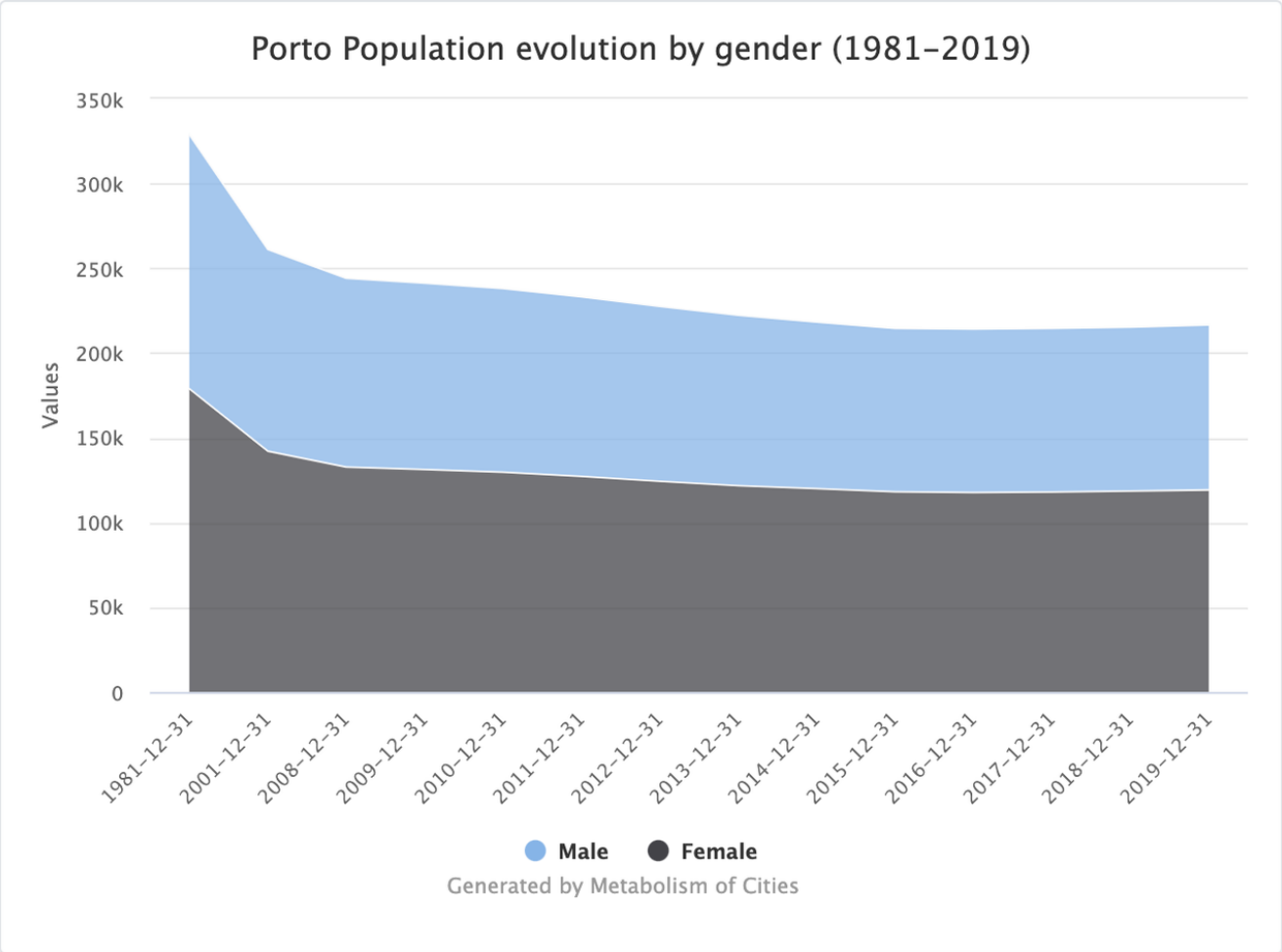
92,226 km^2

Population of Porto



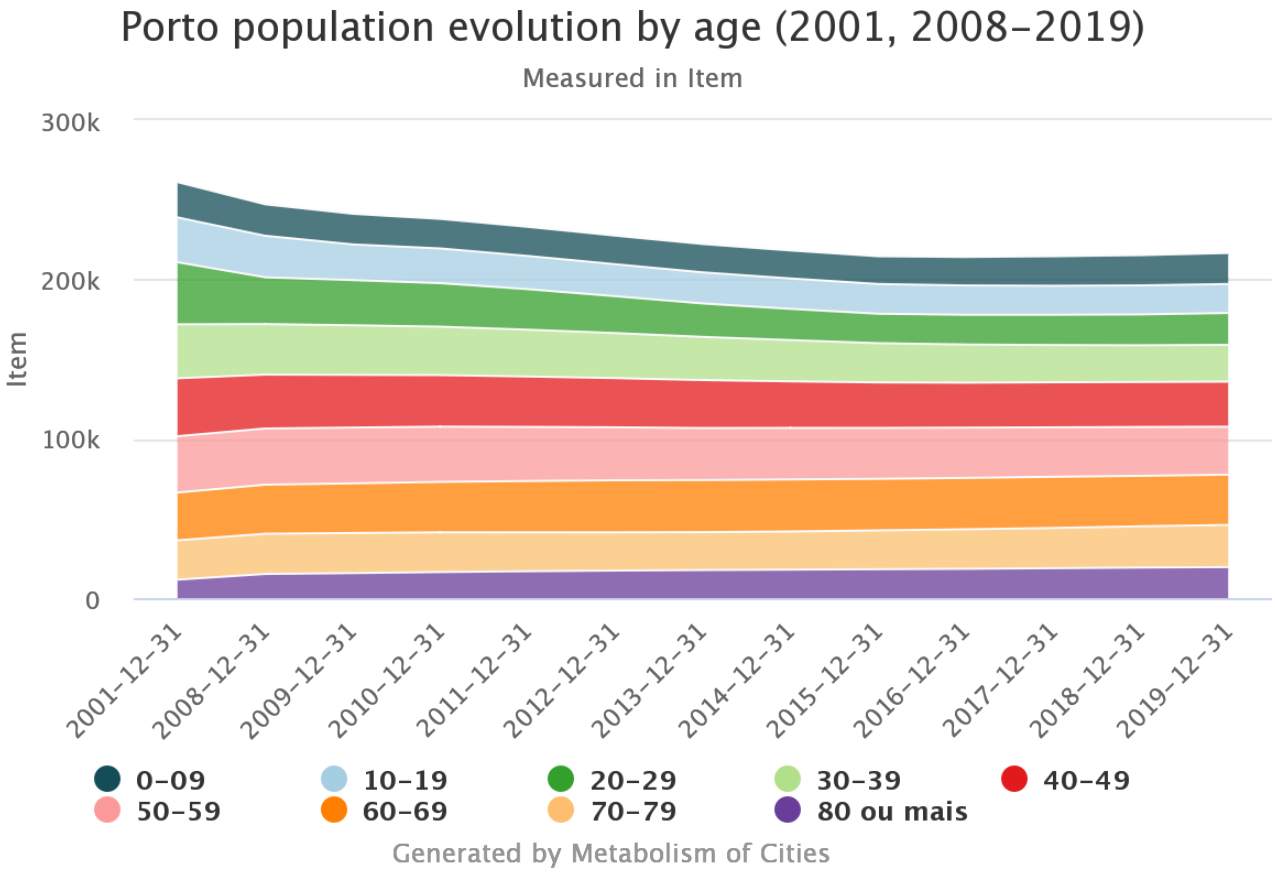
Data source

Despite the fact that Porto has suffered high population decline in recent decades, it looks like it has seen a small population growth since 2017, in part as a result of the city's rising reputation as a place to live. Nowadays, around 216,606 persons (2019) live in the city. The city is in majority female with 55% of the population and 45% being male, following the trend of the regions where it is located and of the country itself.



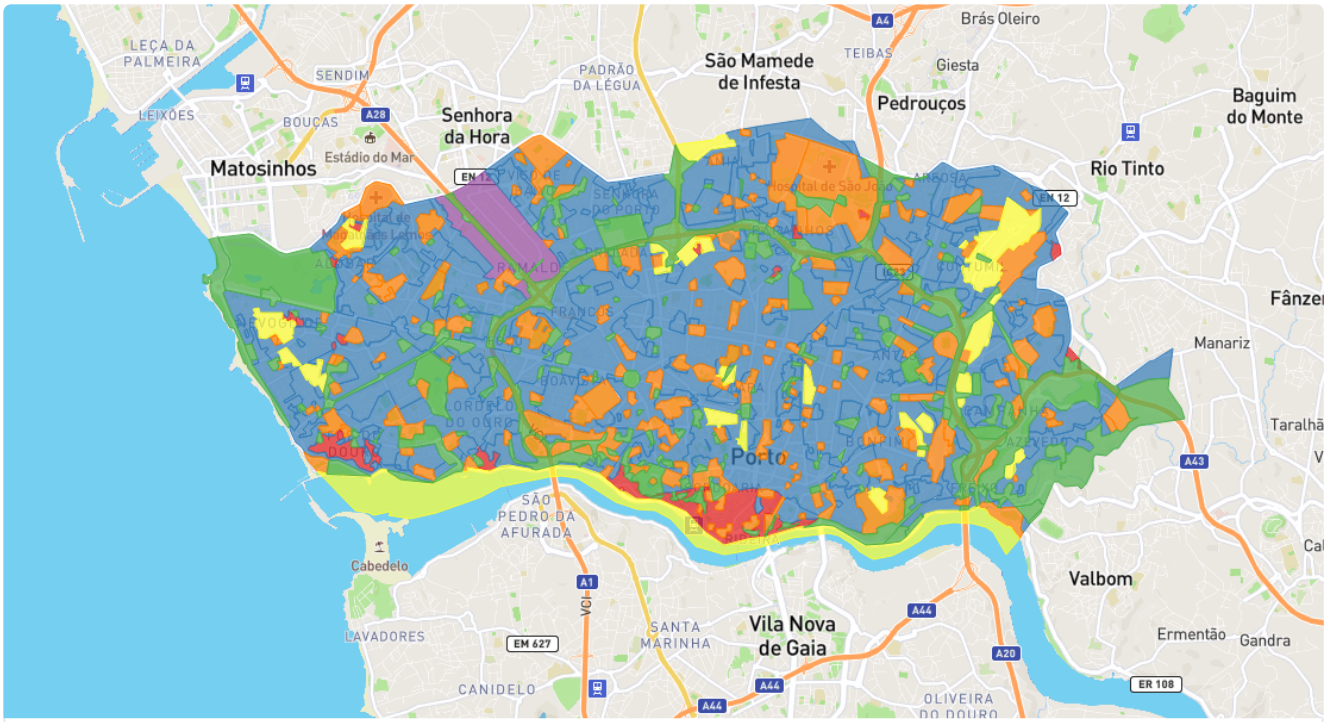
Data source

In terms of age, as shown in the 2019 data, 72% of the population of Porto are between 0 and 64 years and the elderly population represents 28% of the total population.


Porto population evolution by age (2001, 2008–2019)
Measured in Item
300k
200k
100k
0
Item
2001-12-31
2008-12-31
2009-12-31
2010-12-31
2011-12-31
2012-12-31
2013-12-31
2014-12-31
2015-12-31
2016-12-31
2017-12-31
2018-12-31
2019-12-31
0-09
10-19
20-29
30-39
40-49
50-59
60-69
70-79
80 ou mais
Generated by Metabolism of Cities

Data source

Land use



Data source

Porto's land use is urban and mostly classified as space for economic activities with 21.63 ha. The historic area is composed of 1.39 ha and the residential space occupies 1.23 ha of the territory. The green spaces only occupy 0.58 ha of the territory.

Economic context of biomass sector

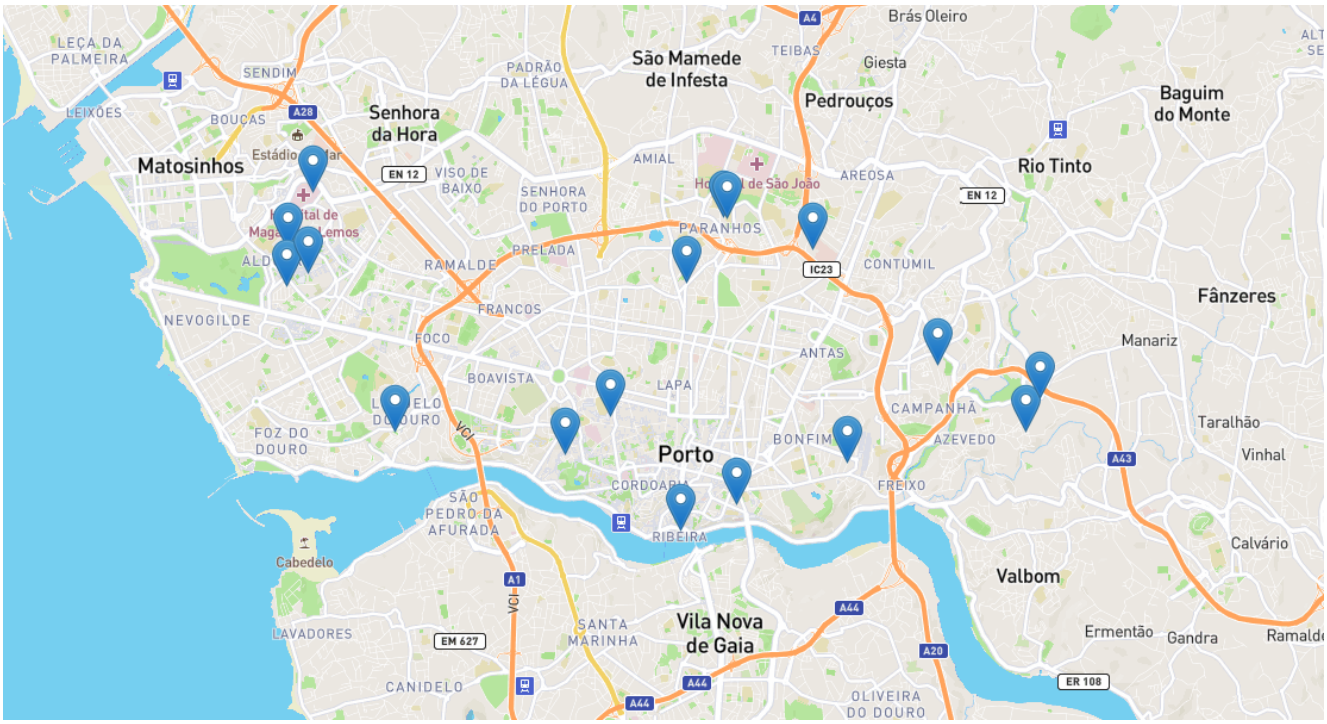
This section puts into perspective the economic context of the sector under study. It describes how many people are employed in this sector, as well as who the main actors involved (from all lifecycle stages for the sector's materials) are.

	GVA (monetary value, in €)	Employees
Porto	548,104,939	31,981

	GVA (monetary value, in €)	Employees
Área Metropolitana do Porto	2,136,865,552	127,700
Norte	3,418,700,948	247,985
Portugal	14,196,449,624	819,111

The biomass sector in Porto

In terms of harvesting, the city of Porto has some small local farmers, producing either for their own consumption, for sale to individuals, or for collaboration with agricultural cooperatives. It is also possible to find in the city the municipal nursery and 13 municipal urban farms available and for the benefit of the community.



Data source

Within the City of Porto, as far as manufacturing industries are concerned, it is possible to identify three factories oriented towards the food sector, namely one whose economic activity is sugar refining and two others of which both operating at the cereal milling level, and one of the companies (Cerealis), in addition to the factory located within the limits of the municipality of

Porto, also has as a sector of activity the manufacture of pasta and the production of cookies, crackers, toast and preserved pastry, whose manufacturing takes place outside the municipality. There is also, within the beverage industry, some production of craft beer in the city.

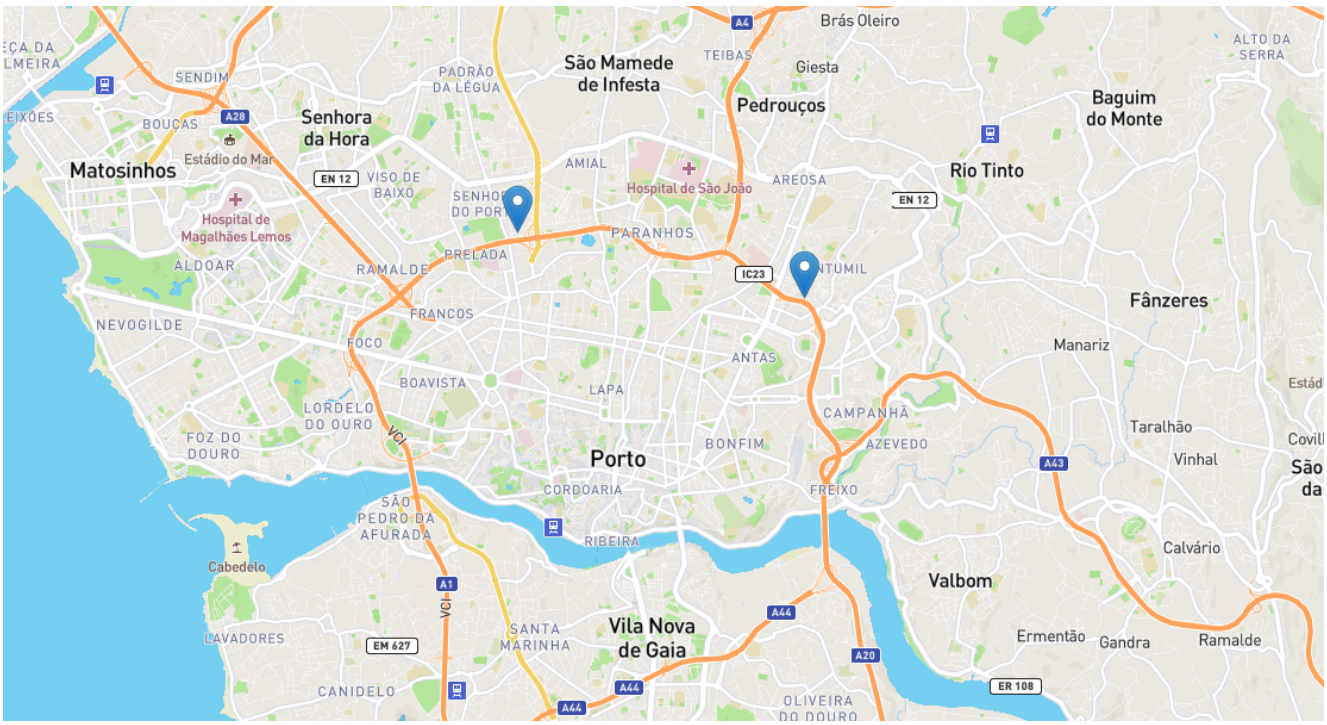
Regarding agricultural production, it occurs mostly outside the limits of the Municipality of Porto. However, although few, it is still possible to identify and locate some independent individual producers in the city, who grow and produce their agricultural products and cooperate with the Cooperative Fruta Feia, to which they sell the fruits and vegetables that they could not sell, due to their appearance or size; and also, independent producers selling their organic products on the platform Reforma Agrária.

The City of Porto is very much dominated by the tourism sector, so you can find a hotel or restaurant almost at every corner. The same can be said about commerce, with plenty of supermarkets and hypermarkets scattered around the city, as well as local markets and fairs (retail infrastructures), in which we can refer the biologic products fair in Porto City Park. Wholesale trade is mainly represented by the Mercado Abastecedor do Porto.

The City of Porto is also home to several educational, research institutions and startups, which contributes to the increase of the qualification of young population as well to the growth of the local economy, making the development of research and technological advances in the biomass sector and beyond possible. Some good examples of innovative projects in the field of food sector, that can be mentioned between many others, are Fairmeals, Noocity, Fruta Feia, Matter and MudaTuga projects.

In 2017, the Municipality of Porto created Porto Ambiente, which is the Environmental Company of the Municipality of Porto, in charge of managing urban solid waste and cleaning the public space (previously performed by private entities). Porto Ambiente is responsible for the collection of urban waste, ensuring the selective collection of recycled waste, such as packaging (plastic and metal), paper/cardboard, glass and bio-waste.

As the entity responsible for the management of urban waste in the municipality of Porto, Porto Ambiente provides around 3600 equipment for selective waste disposal and 5200 equipment for depositing mixed waste, distributed throughout the city, as well as two Civic Amenity Sites (CAS of Antas and CAS of Prelada), for the collection of Construction and Demolition Waste and bulky waste.



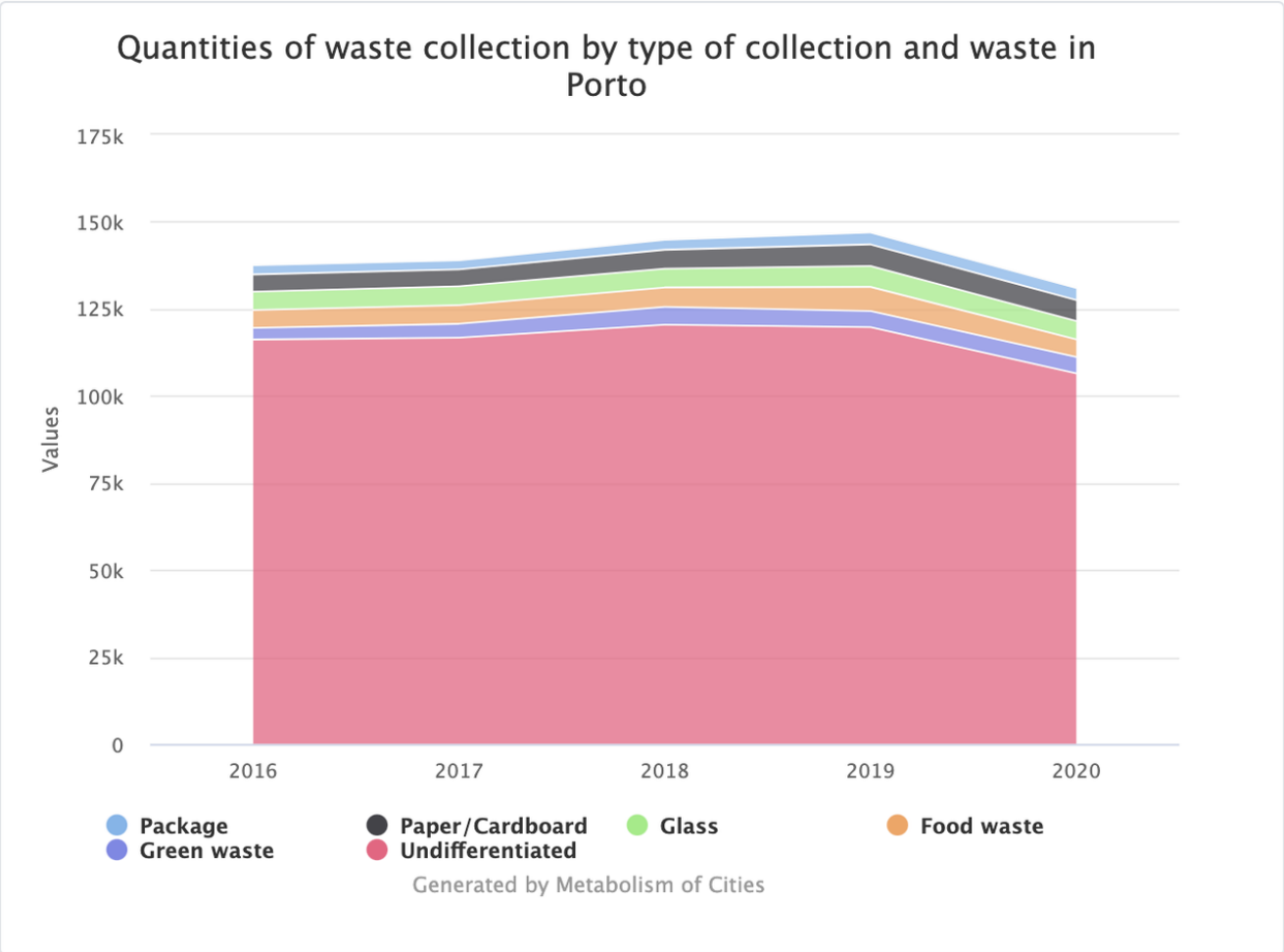
Data source

With regard to food waste, the door-to-door collection service in HORECA (Hotels, Restaurants, Cafés) channel began in 2008. Only in 2018, this type of food waste collection system was possible to expand to households, in some areas of the city of Porto, covering 30% of the city. Earlier in 2021, a new project for the collection of food waste in residential areas – Orgânico project-, through street bins has begun reaching 60% of the city. It's expected to have around 600 bins by the end of 2021.

The door-to-door collection applied to both sectors, commercial and residential, includes the selective collection of paper/cardboard, plastic/metal, glass and food waste. The collection of mixed waste is also included in this service.

Porto Ambiente also has a free service for collecting garden waste at home as well out-of-use objects (such as furniture) and electrical & electronic equipment.

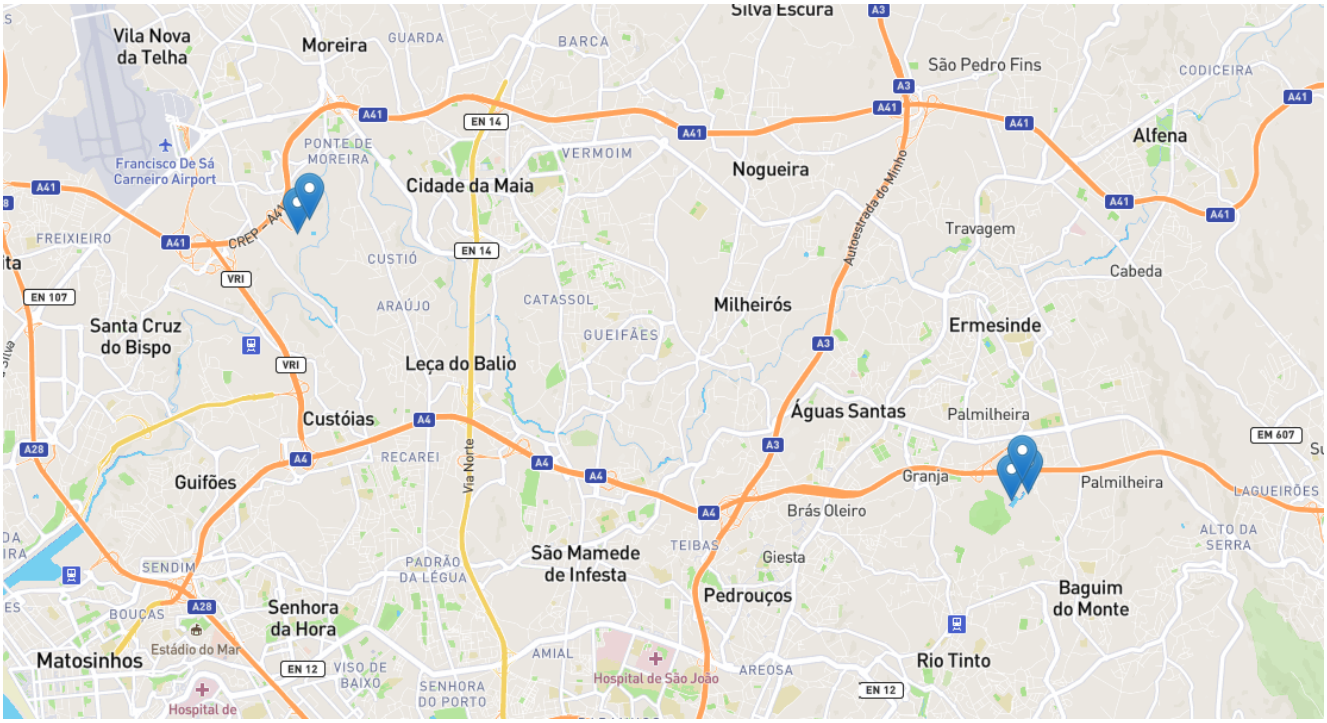
In 2019, the separate collection of food and garden waste had the values of 6,943 and 4,591 tons, respectively. The value of food waste collection is expected to increase in the future with the implementation of the food waste separate collection project, which has begun in 2021 and it's a part of the CityLoops project, more specifically at Demonstration Action 1.



Data source

After being collected, the waste is sent to LIPOR that has two main locations both outside the City of Porto. LIPOR is the Intermunicipal Waste Management Service of Greater Porto, an association of 8 municipalities (Espinho, Gondomar, Maia, Matosinhos, Porto, Póvoa de Varzim, Valongo and Vila do Conde) upholder by modern waste management concepts which promote the adoption of integrated systems and the minimization of waste disposal in landfill.

LIPOR has developed an integrated management strategy based on four key components: Multimaterial Recovery, Organic Recovery, and Energy Recovery, supported by a Landfill Site to receive the waste from processes and from previously prepared waste.



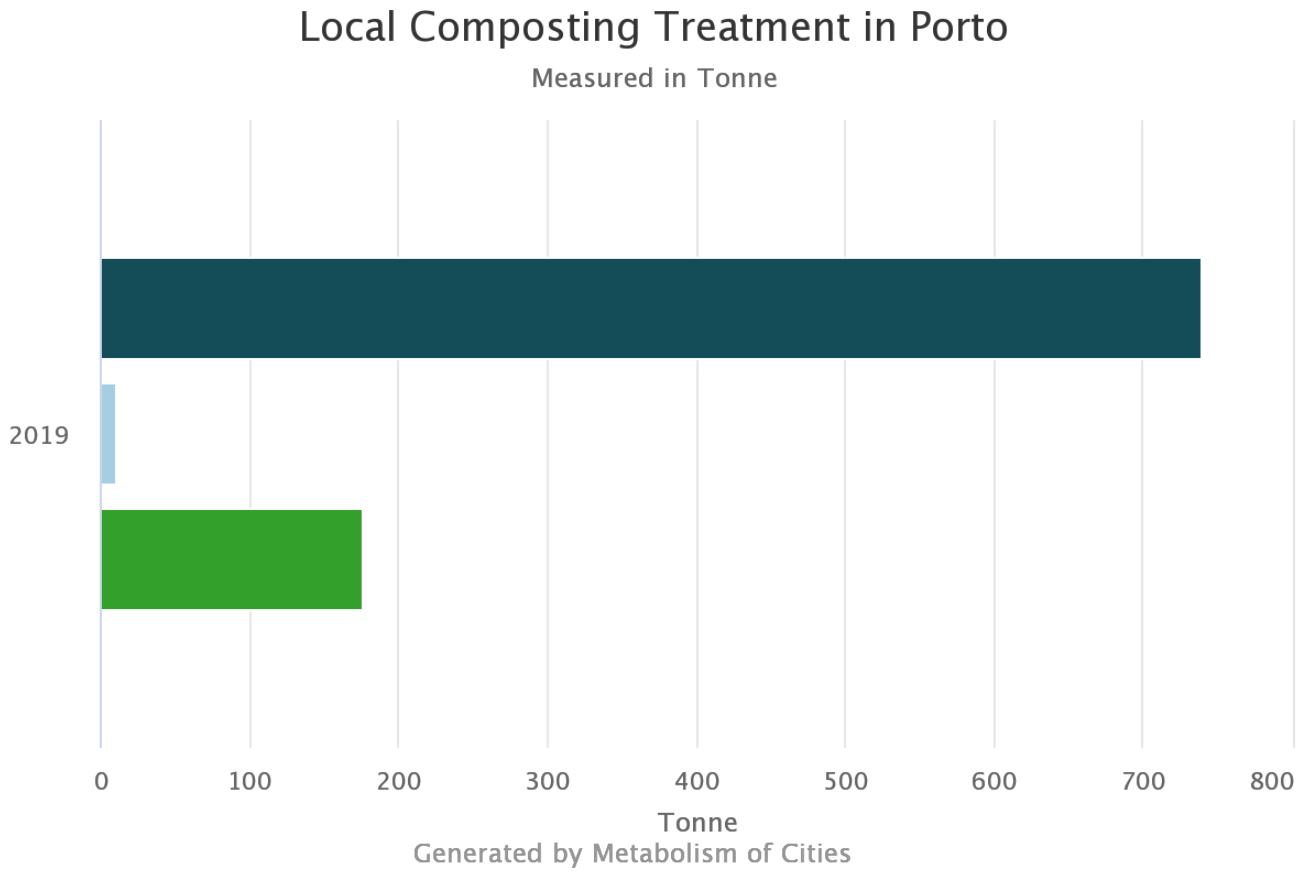
Data source

In 2019, LIPOR has received in its facilities approximately 545 thousand tons of urban waste (146,870 tons from the City of Porto), of which, about 74% were sent to the WtE Plant. According to the Integrated Report of 2019, from LIPOR, 58,791 tons of bio-waste waste were delivered to LIPOR's facilities.

The LIPOR Composting Plant, activated in 2002 and located in Baguim do Monte, has the capacity to recover 60 thousand tons/year of bio-waste from selective collection and it uses an in-vessel composting process, generating a high-quality organic soil ammender - the NUTRIMAIS (around 12 thousand tons/year of organic compost).

In the City of Porto, home and community composting is also an applied solution to treat bio-waste locally, and it is possible to find different types of composters (around 2,400) in homes, social organisations, municipal gardens, and composting islands, treating an estimated total of 927 tons of waste treated in local composting per year. The graphic below shows how this is distributed between home composting (dark blue, 740 tons), community composting (light blue, 11 tons) and urban farm composting (green, 176 tons).

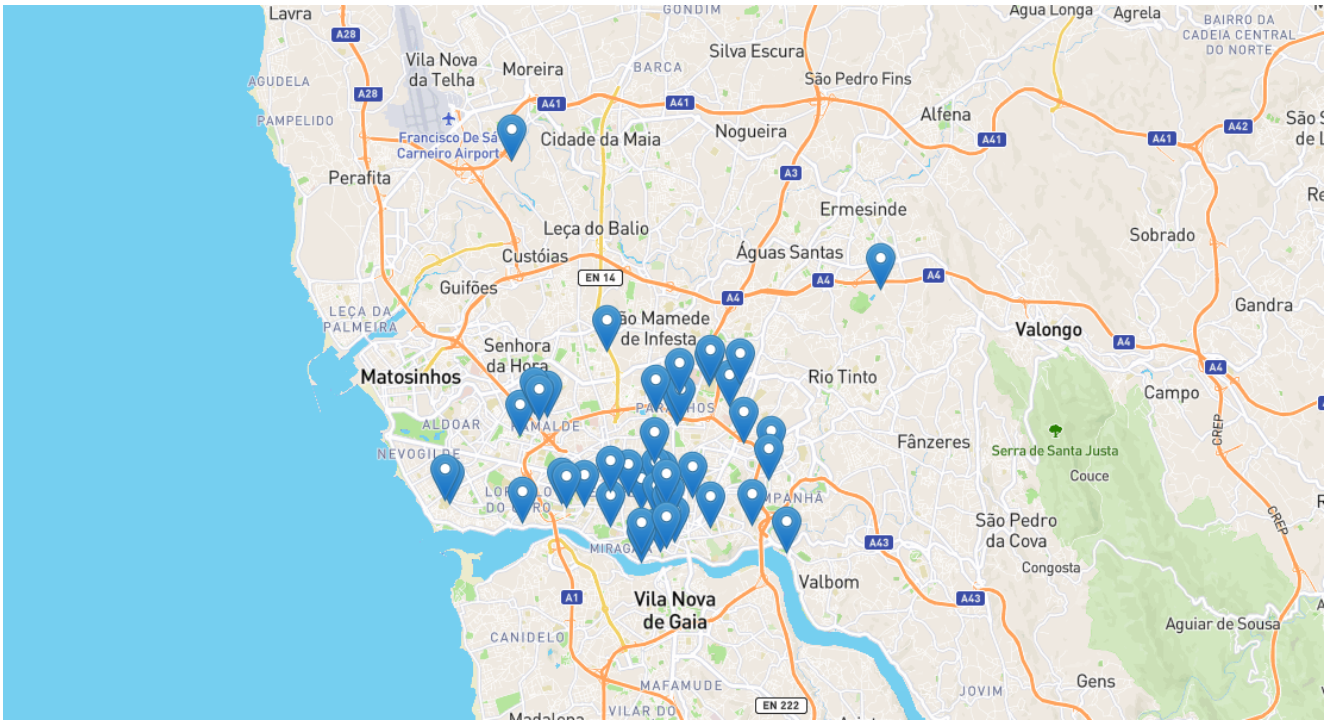
Within the CityLoops project, there were implemented local community composters this year (2021) - two areas with 15 community composters island in total and individual composters distributed to households to feed the new composters. The model is being tested with the vision to expand the local solution of food waste treatment and compost production to other areas of the city.



Data source

The LIPOR Waste-to-Energy Plant, located in Maia, intends to recover, in the form of electric energy, the waste fraction that cannot be used through composting and recycling processes. The WtE process occurs at a high temperature (between 1000ºC and 1200ºC) under excess oxygen conditions. The plant is energetically self-sufficient, that is, the plant has a treatment capacity of 38 000 tons of waste per year and produces about 170 000 MWh of electricity per year, of which about 90% is injected to the Portuguese national electricity grid network.

The actors of the biomass sector



Data source

When it comes to harvesting, there are small local farmers who, although it has not been possible to quantify them, entities such as AMAP Porto (Associação pela Manutenção da Agricultura de Proximidade), APANP (Associação dos Proprietários e Agricultores do Norte de Portugal) and the Associação dos Agricultores do Porto have been identified as representative of this subject.

In Porto, there are no extractive industries, but rather transforming industries, at the level of sugar refining (RAR), grain milling and pasta manufacturing, cereal and legume processing, and the manufacture of cookies, crackers, toast and preserved pastry (Moagem Ceres and Cerealis), as well as small several bread and pastry manufacturers, in the food industry, and also, in the beverage industry, it is possible to find some small craft brewers (e.g. Nortada).

The City of Porto also has plenty of retail infrastructures, from supermarkets to hypermarkets or convenience stores, which unfortunately follow the Portuguese trend regarding long food supply chains (90% of the food available); the main wholesale establishment in the city is the Mercado Abastecedor do Porto, where you can buy all kinds of food in bulk. Not forgetting the iconic Bolhão Market, where you can find all kinds of fresh and organic products, from fruit, vegetables, fish and meat, supporting short supply chains with regional food.

There are also several street local markets with the purpose to support the local economy, that are usually held on a weekly basis, where can be find a wide variety of products, from clothing, live animals, plants and flowers and food products. There is also the weekly Fair of organic products

market - a municipality-led initiative ongoing since 2004. It is organized in collaboration with a food producers' commission and takes place in the Porto's City Park on every Saturday mornings, stimulating local and regional production and consumption.

Porto is also very much driven by the hotel and restaurant (tourism) sector, and some associations representing these sectors have been identified as main actors, such as AHRESP (Associação da Hotelaria, Restauração e Similares de Portugal) and APHORT (Associação Portuguesa de Hotelaria, Restauração e Turismo).

Within the city you can find several educational and research institutions, also very important when it comes to the development of studies related to biomass, for example, the Faculty of Engineering, the Faculty of Sciences and the Faculty of Nutrition and Food Sciences of the University of Porto and the Superior School of Biotechnology of the Catholic University. Or even research institutions such as LNEG (National Laboratory for Energy and Geology), INESC TEC (Institute for Systems and Computer Engineering, Technology and Science) or, when it comes to development and innovation, the UPTEC (Science and Technology Park of the University of Porto) and the Porto Innovation Hub (an initiative of Porto Municipality).

Regarding the waste companies with the responsibilities of bio-waste collection (within the city) and treatment (outside the city), we can refer the Porto Ambiente and LIPOR, respectively, as explained in the previous chapter.

Indicators

To monitor the progress of this economic sector towards circularity, a number of indicators were proposed and measured. Altogether, these indicators depict several facets of circularity of the sector. As such, they need to be considered in combination rather than in isolation when assessing circularity. In addition, these indicators can be compared to other cities or spatial scales (such as the country level). However, this has to be done with great care and use of the contextual elements in the previous sections of the report. Finally, the value measured from these indicators can be traced over time to track the sector's progress towards circularity.

Indicator number	Indicator	Value	Unit
34	Domestic material consumption (DMC)	274,666.88	Tonnes/year
41	Share of secondary materials in DMC	1.25	%
48	EU self-sufficiency for raw materials	66.69	%

Indicator number	Indicator	Value	Unit
53	Quantity of material for anaerobic digestion	0.00	Tonnes/year
56	Quantity of material for composting	12,548.38	Tonnes/year
57	Amount of sector specific waste that is produced	39,364.38	Tonnes/year
58	End of Life Processing Rate	19.90	%
59	Incineration rate	68.12	%
61	Landfilling rate	2.04	%

Indicators #34, #41, #48

- Domestic material consumption (DMC): 274,666.88 ton
- Share of secondary materials in DMC: 1.25%
- EU self-sufficiency for raw materials: 66.69%

In the first indicator (DMC, #34) it was estimated a value of 1,268 ton per capita, lower than the value for Portugal (3,367 ton per capita).

Considering the value of the share of secondary material in DMC, the value is very low (1.25%), but with the increasing values for separate collection of bio-waste and the subsequent production of compost in LIPOR composting plant, located outside the city boundaries, and its partial application in the City of Porto, the value of this indicator will increase in the following years. For the increase of this value, it will also contribute the increase of local composting, considering the home composting, community composting and urban farms composting.

Indicators #53, #56, #57

- Quantity of material for anaerobic digestion (#53): 0.00 ton
- Quantity of material for composting (#56): 12,548.38 ton
- Amount of sector specific waste that is produced (#57): 39,364.38 ton

Analyzing these three indicators, it is possible to observe that 31,9% of the bio-waste produced in the City of Porto (39,364 kton) went to LIPOR composting plant (12,548 kton) in 2019. This might be the result of the implementation of the separate collection system of food and garden waste in the city. This percentage is rapidly increasing due to recent investments done by Porto Ambiente and will have a significant increase during the following years, as a result of these investments, including the investment in CityLoops Demo Action #1.

We can refer that LIPOR is preparing an investment on a new anaerobic digestion to treat bio-waste from the increasing separate collection systems being implemented in all the eight Municipalities in LIPOR region. This means that in the future indicator #53 won't be zero like it happens now.

Indicators #58, #59, #61

- EOL processing rate (#58): 19.90%
- Waste-to-energy rate (#59): 68.10%
- Landfilling rate (#61): 2.04%

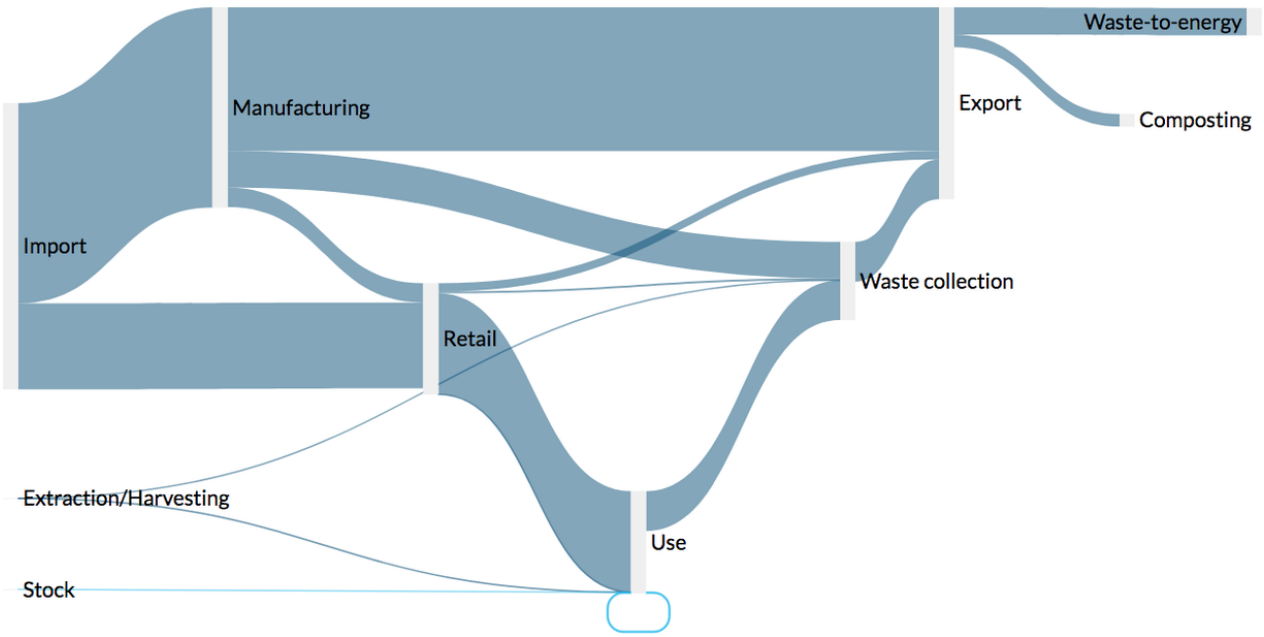
The bio-waste sent to LIPOR composting plant, will produce a high-quality compost, commercialized with the brand "Nutrimais". The processing rate is 19.90%, which means that each ton of bio-waste received in this plant will produce 0.19 tons of compost.

Analyzing the waste-to-energy rate indicator, we can notice that 68.10% of the bio-waste collected in the City of Porto. However, as mentioned before, with the significant increase in the separate collection of bio-waste in the following years, increasing the circularity in the management of the bio-waste produced in the City of Porto, this indicator will decrease.

Considering the bio-waste send to the LIPOR waste-to-energy (WtE) plant, the sub-product of this treatment process (ashes) will be landfilled. Considering that the total amount of bio-waste send to the LIPOR WtE plant will originate 3% of ashes to be landfilled, the landfill rate estimated (#61) is 2.04%.

Visualisations

Measuring circularity is a data heavy exercise. Numerous datasets were collected and visualised throughout the sector-wide circularity assessment process. To synthesise these findings, a Sankey diagram illustrates how material flows from the studied economic sector are circulating from one lifecycle stage to another. The height of each line is proportional to the weight of the flow. This diagram therefore helps to quickly have an overview of all the materials flows that compose the sector and their respective shares. The flows that are coloured in light blue in the Sankey diagram, are return flows. This means that they flow in the opposite direction of the lifecycle stages and are subjected to reuse, redistribution, or remanufacturing. Their size relative to the others is a good indication for the materials' circularity.



Data source

The Sankey diagram describes the large import of materials for the biomass sector in the City of Porto (more than 282 kton in 2019) comparing to the extraction/harvesting activities (only 261 tons in 2019). These means that for the City of Porto almost all the materials required for the biomass sector came from outside the city boundaries.

Most part of the imported materials goes to the manufacturing sector, composed by two medium sized factories (one sugar refinery and two cereal mills) and several small bakeries and patisseries and also some small craft beer brewing companies. The rest of the imported materials goes directly to the retail sector, including wholesale.

Considering this, almost all the food consumed by the citizens or served in restaurants, hotels and canteens aren't produced locally, which reflects the densely urbanized and consolidated territory of the municipality.

At Porto, there also exist some food donation projects implemented in the city, avoiding the production of food waste, increasing the circularity of bio-waste management, such as, the municipal network of solidarity restaurants, the Refood4Good movement, and the Zero waste movement from DariAcordar Association.

Considering the bio-waste produced in the City of Porto, including both food and garden waste, almost all the bio-waste collected – separated and mixed waste collection – is exported to LIPOR plants (composting and waste-to-energy plants) located outside the city boundaries. Only a small portion is treated locally, through home and local composting.

Finally, considering the export, besides the export of the bio-waste collected, we have the export from the manufacturing sector, mainly from the two medium sized factories above mentioned, and from the retail sector. This numbers were estimated because it wasn't found data that allows us to include precise and accurate data for the City of Porto.

Data quality assessment

Numerous datasets were collected and considered in the sector-wide circularity assessment. In some cases, datasets were not available for some materials or for some lifecycle stages for the studied sector. Therefore, estimations need to be done by looking at data at higher spatial scales (region or country). This section qualitatively assesses how reliable the data used is.

Data quality

Before describing data gaps and assumptions, the overall data quality is considered. It is expressed through four data quality dimensions that are depicted in the data quality matrix: reliability, completeness, temporal correlation, and spatial correlation. Each dimension has its own criteria for the ranking of high (green), medium (yellow) and low (red), which is based on this Pedigree report and shown in the table below. There can be additional explanations in some cells, as supporting information.

Rating	*Reliability*	*Completeness*	*Temporal correlation*	*Spatial correlation*
high	*Reviewed or measured data*	*Data exists for all of the single materials and their respective economic activites*	*Data less than 3 years difference to the time period of the data set*	*City-level data*
medium	*Estimated data*	*Data exists for most single materials and most economic activities*	*Data less than 6 years difference to the time period of the data set*	*Regional-level data (NUTS 3)*
low	*Provisional data*	*Data exists for the sector only for the Life Cycle Stages*	*Data less than 10 years difference to the time period of the data set*	*NUTS 2 and country-level data*

Data quality matrix

Lifecycle stage	Reliability	Completeness	Temporal correlation	Spatial correlation
Extraction/Harvesting				
Manufacturing				
Retail				
Use				
Stock				
Waste collection				
Landfill				
Incineration				
Recycling	Not applicable	Not applicable	Not applicable	Not applicable

Lifecycle stage	Reliability	Completeness	Temporal correlation	Spatial correlation
Anaerobic digestion	Not applicable	Not applicable	Not applicable	Not applicable
Composting				
Imports				
Exports				

EXTRACTION AND HARVESTING

Data source was the National Institute of Statistics (INE), namely, regarding permanent and temporary crops in the City of Porto.

There is no data or information about other type of extraction/harvesting taking place in the City of Porto.

MANUFACTURING

Apart data from the sugar refinery (data estimated considering information from the annual financial report), the remaining manufacturing data (grain milling, brewing, local bakery and pastry) were obtained by downscaling 2019 statistical data from INE at the country level to the city scale. The data was considered to cover the main actors and manufacturing infrastructures identified in Porto.

RETAIL

INE data was found at the Metropolitan Area of Porto (AMP) level for production (of products created during the accounting period), in euros, for all types of economic activities, including retail and wholesale trade for different biomass materials. Subsequently, the respective annual quantity was estimated for each of the materials, considering the average market price, with the consequent downscaling of the data to the city level.

USE

Statistical data on food consumption, of the different biomass materials, were collected from INE (per capita consumption, kg/inhab) at the country scale and, from income and number of inhabitants, it was possible to convert to the city of Porto. We also collected data from some

ongoing projects of food waste prevention that have been implemented in the City of Porto, such as the recovery of leftovers from restaurants, canteens and supermarkets, and also data on meals served in social/municipal and school canteens.

STOCK

Data regarding existing animals in the municipality of Porto was obtained from INE. Although it is known that there is tree stock in the city (green spaces and nursery), it was not possible to obtain or to convert this information in tons.

WASTE COLLECTION

Waste collection data was provided by Porto Ambiente and LIPOR. The bio-waste selective collection data was provided by Porto Ambiente. The mixed waste collection was provided by LIPOR. Nevertheless, we should mention that this data was calculated since LIPOR can´t provide an exact number for the waste collected. Although LIPOR can provide an exact figure for the mixed waste collection in Porto, the waste characterization is made for the whole system (8 municipalities), so the figure presented for bio-waste in the mixed waste for Porto must be calculated. Additional information was collected regarding local composting initiatives.

Data gaps and assumptions

The only real data that has actually been obtained for the City of Porto is in terms of crops (temporary and permanent crops), animal stock, waste collection and food donation projects. All other data were obtained by downscaling to the city or by doing estimations (local composting projects).

The main source used for data collection was INE, and other data was obtained from LIPOR, Municipality of Porto City and Porto Ambiente.

For the downscale, besides having resorted to income figures and the number of employees, it was also necessary to find some average values, such as market prices of products and mass quantities of meals.

Data regarding the number of employees and GVA of the biomass sector in Porto (considering all the associated economic activity sectors) could be improved and could be more realistic if more detailed information were available (4-digit NACE codes), so these values had to be estimated from the other geographical scales (NUTS 3, NUTS 2 and Country).

Since no specific data was found for biomass for imports and exports, it was assumed that the value of imports would be equivalent to the total value of manufacturing and a portion of retail, and for exports it was assumed that all collected waste is exported out of the city (to neighboring municipalities).

Data analysis

This section analyses the Sankey diagram developed in the previous section. It discusses and interprets the results for the sector-wide circularity assessment. It also reflects on how the current demonstration actions fit within the bigger picture of the sector, as well as how they could be upscaled to accelerate the transition towards a more circular sector.

Insights on status quo of the biomass sector

The Sankey diagram of the City of Porto shows us that almost all the materials of the biomass sector comes from import. This means that, to decrease the import of materials and to avoid bio-waste production, it should be implemented several measures to promote more circular flows in the city as well to upscale the ongoing circular projects For instance, the ones related with separate collection of bio-waste (associated with the production and use of high-quality compost), local composting treatment (like home and community composting), food waste reduction initiatives (Embrulha), food donation networks, local/regional sustainable food production and sustainable food procurement.

The current circular initiatives in the biomass sector have currently a small impact in the circularity in the City of Porto, despite all the efforts already done by public and private entities. But we need to be aware that some of these initiatives are very recent, like the new municipal separate collection of bio-waste or the promotion and implementation of local community composting schemes and even food waste prevention programs.

The food donation projects, linking sectors like retail and restaurant sectors with institutions from the social sector helping families with low-income or in a situation of social exclusion, as well some projects promoting food waste prevention coordinated by LIPOR ("the right portion" and "wrap it up") or other entities (DariAcordar Association – Zero Desperdício Program; or Refood4Good Association), needs to be upscaled to assure bigger impact than it happens today.

But, considering the current situation, it won't be easy to promote a full circular biomass sector in the City of Porto because most of the materials included will continue to be imported since it won't be possible to produce most of them locally, inside the city boundaries.

Connection to and upscaling of demonstration actions

The CityLoops demonstration actions (DAs) in Porto target mainly the food waste, which is a very important flow of bio-waste within the urban solid waste, with the goal of promoting a more circular management of bio-waste. But the DAs at the City of Porto aim also to promote a more sustainable and local/regional food production as well the use of new tools to adjust the food procurement to the real needs of the institutions participating in the two pilots' projects: pilot hotel (tourism sector) and a private social solidarity institution (social sector).

DAs like the implementation of new bio-waste selective collection in high-rise residential areas and local treatment solutions like community composting islands (DA#1), will promote more circular destinations for the food waste increasing the mass of bio-waste exported to LIPOR composting plant (1.500 ton/year, 10% of the population of the City of Porto), located outside the city boundaries, as well the increasing of the bio-waste treated in local composting (15 ton/year). This DA upscaled to other parts of the City of Porto could have a relevant impact in the circularity of the management of the food waste management produced in Porto.

Another DA which could have a relevant impact when upscaled is the bio-waste circularity models (DA#2) that will be tested during CityLoops in a pilot hotel (tourism sector) and a private social solidarity institution (social sector). These models were designed to significantly reduce food waste in both the tourism (hotels and restaurants) and social economy sectors (canteens), which are currently big local producers of bio-waste. This means that, these circularity models, after being tested and validated, being upscaled could represent an opportunity to promote bio-waste reduction and prevention, closing the loop of organic matter from farm to fork. In these pilots it will be implemented actions like the promotion of local consumption (promoting food from local/metropolitan producers), local and regenerative production (including local vegetable production with growbed kits), more sustainable menus (promotion of sustainable food), surplus food redirection, bio-waste local treatment and separate collection of bio-waste.

Another DA that can improve the circularity in the biomass sector is the launch and implementation of the green space certification system (DA#3), seeking to increase the sustainable management of green spaces, as well to promote biodiversity. The certification system will specifically encourage dedicated gardening practices to promote the use of the compost produced at LIPOR's composting plant, in order to highlight the importance of returning bio-waste to soil in the form of compost and the sustainable management of green spaces, increase its circularity. The upscale of this DA could have a relevant impact in the circularity of the management of materials of the green spaces, publics and privates, in the City of Porto.

A fourth DA is the promotion of Circular Entrepreneurship Initiatives (DA#4), which consist of a a Contest for Circular Ideas, designed during CityLoops, in order to promote the circular transition in bio-waste and more broadly in the food system. For now it's impossible to estimate the potential impact of this DA, but, after the submission and selection of 20 ideas and after choosing the 5 best ideas that will have access to a set of resources to support its implementation, it will be created all the conditions to increase the number of new circular initiatives related with bio-waste and the food sector being implemented in the City of Porto.

Finally, the DA#5 will support and expand the food donation network, already occurring in the city, which connects food distribution (restaurants and similar, hotels and companies in the wholesale and retail sector) and social economy sectors to support citizens with low income and social needs in the city of Porto. This action will also allow food waste reduction in the city and could have a relevant impact in the circularity of the biomass sector.

Recommendations for making the biomass sector more circular

The recommendations for making the biomass sector more circular in the City of Porto are aligned with:

- The commitment to become a circular city by adopting, in 2017, a Roadmap for Circular Economy in 2030. With the collaboration of different organisations and citizens, **four main axis** were defined: 1. Promote sustainable production and consumption; 2. Ensure the availability of natural resources and environmental balances; 3. Create and maintain shared infrastructures, rehabilitate buildings and create circularity guidelines for new constructions; 4. Promote innovative solutions to transform waste in resources.

- The Food System City Approach to a circular and regenerative food system. Prevention of food waste is a key part of this strategy, and with regard to the circular economy the management of bio-waste sector is one of the pillars to address it. However, Porto believes that reducing food waste requires a holistic approach regarding the local food system, in this sense, it was established in 2019, with the collaboration of Ellen MacArthur Foundation and other national stakeholders, a holistic vision to the food system including food waste in an integrated way by jointly addressing food waste reduction, bio-waste management and food production. This vision is based on **three ambitions**: 1. Promotion of a regenerative and local agriculture through local and regional production; 2. Promotion of healthy food through design, market and public procurement; 3. Prevention of food waste through making the most of the food - prevention, reduction and valorisation.

CityLoops is contributing to achieving the vision to a circular and regenerative food system and the sector-wide circularity assessment is a fundamental piece to support decisions.

Some of the recommended actions are:

- Encourage the transformation of food production sector (at city and metropolitan scale), requiring less negative impacts and reducing the production of food waste throughout the value chain;
- Promote the increase of small production units (local and metropolitan producers) in Porto Metropolitan Area as well the increase of urban farming in the City of Porto;
- Disseminate the inclusion of circular economy criteria (efficiency in the use of resources, proximity to the production site, separate collection, local composting, e.g.) in the public procurement procedures of the Municipality of Porto, specially for procedures related with municipal canteens and maintenance of green spaces;
- Support the creation and development of new business models that promote the closing of nutrient cycles and an urban bioeconomy in which nutrients are properly returned to the soil, with a reduction in waste;
- Support initiatives to collect food leftovers, in particular through the Horeca and Retail channels, developing systems to collect and dispose of food leftovers, whether for social purposes or for recovery by industry;

- Upscale the separate collection of food and garden waste to all the City of Porto, promoting the closing of the loop for these materials exporting the bio-waste collected to LIPOR's composting plant (current), located outside the City boundaries. In the following years LIPOR will invest in an anaerobic digestion plant, which will help to make the sector more circular;
- Disseminate the use of the compost produced in LIPOR's composting plant in green parks, privates and publics, in the City of Porto;
- Increase the number of citizens engaged in home composting, as well the increase the community composting islands;
- Promote the treatment and the use of the organic compost at the local level.

References

- Portugal
- Norte
- Área Metropolitana do Porto
- Population evolution of Porto (1981-2019)
- Land Use Charter - Porto
- Main Actors in Porto map